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Elasticity of Diopside at High Pressure and High Temperature

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Beamline(s): X17B1

Introduction: Pyroxenes are the second major compositional component in the Earth's upper mantle. Elastic properties of these minerals at high pressure and high temperature play important roles in understanding the composition, structure and dynamics of the Earth's interior. For instance, the seismic discontinuity at 220 km has been considered to be caused by the structure change of pyroxenes at this depth. Using laboratory measured elastic properties for candidate minerals, one can construct velocity-depth profiles and compare with seismic results to constrain their proportions in the composition of the Earth's upper mantle.

Methods and Materials: Simultaneous compressional (V_p) and shear (V_s) wave velocity measurements and equation of state (P-V-T) studies have been implemented using ultrasonic interferometry and in-situ X-ray diffraction techniques in a DIA-type, cubic anvil high pressure apparatus (SAM85) at beamline X17B at NSLS in Brookhaven National Laboratory (Liebermann and Li, 1998). To study the elastic properties of diopside, a polycrystalline specimen was hot-pressed at 10 GPa and 1100°C in a 1000-ton Uniaxial Split Cylinder Apparatus (USCA-1000) using diopside glass as starting material. Synchrotron X-ray diffraction spectrum indicated that the product was a single phase of diopside. Ultrasonic measurements are conducted by mounting an acoustic transducer at the back of the WC anvil and enclosing polycrystalline alumina as extended buffer rod inside the Boron epoxy pressure medium. Both P and S wave travel times are measured at the same time using a 10-degree Y-cut lithium niobate transducer. The sample is surrounded by NaCl and BN to minimize non-hydrostatic stress.

Results: X-ray diffraction from both the sample and NaCl were recorded at elevated pressures and temperatures from which the unit cell volumes of the sample and sample pressures were obtained. Completed P-V-T and V_p and V_s data for the specimen have been collected up to 8 GPa and 1200 K with heating/cooling cycles at 2.2, 4.1, 5.4, 6.5, and 8.0 GPa. Analyzing P-V-T and acoustic data produce independent determination of elastic moduli K and G and their pressure and temperature derivatives for this upper mantle phase, which are very important parameters needed for modeling mantle compositions and interpreting the 220-km discontinuity.

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References: Liebermann, R.C. and B. Li, Elasticity at high pressures and high temperatures, *Review in Mineralogy*, 37, pp. 459-492, 1998.